CHAPTER VIII

DRAWINGS

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Chapter VIII

DRAWINGS

1. **PURPOSE AND SCOPE**. This guidance establishes uniform drawing standards for Architect-Engineers (A-E), design-build contractors and Government personnel preparing design, engineering and construction documents, other than shop drawings, pursuant to a contract with Districts in the Southwestern Division. These standards are to facilitate preparation, review and a clear understanding of the contract documents.

2. **REFERENCES:**

2.1 ER 1110-345-700 Engineering and Design, Design Analysis, Drawings and Specifications, Appendix C, - Drawings.

2.2 A/E/C CADD Standards Manual (current edition). A copy of the standards can be downloaded from the Internet at the Waterways Experiment Station (CEWES), CADD/GIS Technology Center (http://tsc.wes.army.mil). A CD ROM disk with the manual and other CADD system data can be ordered at the same Internet address or can be obtained from the CADD/GIS Technology Center (CEWES-ID-C), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

3. **CADD OPERATING PROCEDURES.** All original and finished drawings will be produced using Computer-Aided Design and Drafting (CADD). Existing hard copy data to be included in construction projects shall be scanned to raster format (minimum, vector preferred) and submitted with all required electronic files.

3.1 **CADD Software.** The basic software package used to create contract drawings shall be Bently Inc.'s, MicroStation® or Autodesk's AutoCad®, as specified by the supervising district. Manually drawn sketches may be used for schematic and preliminary studies.

3.2 **CADD Standards.** The A/E/C CADD Standards Manual was developed by the CADD/GIS Technology Center to reduce redundant CADD standardization efforts within the Army, Navy, Air Force, and Corps of Engineers. The manual consolidates various CADD standards used in the Corps of Engineers into a generic format to operate under various CADD software

packages (such as MicroStation and AutoCAD) and to incorporate existing industry and national standards.

3.3 **Graphic Files.**

3.3.1 Drawing CADD Files. Each graphic file should contain the contents of only one drawing (sequence numbered sheet). The architectural floor plan, site master plan, mechanical master plan, electrical master plan, etc. will each be constructed in a separate CADD file. These plans will not be split between two or more CADD files. Designers will use these floor plans/master plans as reference files and not copy them into their sheet design file. This will facilitate the incorporation of plan changes.

3.3.2 File Naming Convention. File names shall be as indicated in the A/E/C CADD standard and/or supervising district standard. The Architect-Engineer should obtain the file naming convention to be used for a particular contract from the district's project Technical Leader.

3.3.3 CADD Conventions. Architect-Engineer will use the CADD level/layer convention, line symbologies, font libraries, and color tables as indicated in the A/E/C CADD standard or as required by the project’s supervising district. The Architect-Engineer should obtain the CADD conventions to be used for a particular contract from the district's project Technical Leader.

3.3.4 Drawing Size. Drawing sizes shall be as indicated in the A/E/C CADD standard and/or supervising district CADD standards. Sketches or reduced size drawings for design brochures should be copying size 215mm x 280 mm (8-1/2"x 11") or 280 mm x 430 mm (11"x17").

3.3.5 Title Blocks/Borders. Standard CADD title blocks and border files for contract documents shall be furnished to the A-E by the district project Technical Leader in the supervising district.

3.3.6 Units. Unless otherwise directed, drawings shall use the metric International System of Units (SI). See paragraphs 2 and 3.2.1 of Chapter I for guidance on metric design policy and application. Additions/modifications to existing facilities may be in the English system of units to

match the units used in the original facility construction if directed by the supervising district.

3.3.7 Scale. Appropriate scales shall be used to produce clearly legible drawing and shall conform to the A/E/C CADD standard and/or supervising district. See paragraph 6.1 for conventional scale standards.

3.3.8 Numbering. Sheet numbers, sequence numbers, and CADD file names shall be as indicated in the A/E/C CADD standard and/or supervising district standards. All design submittals require sheet numbers. See paragraph 6.2 below. Final design and all subsequent design submittals also require sequence numbers. The CADD file name and plot date should be shown outside the border under the title block on all drawings.

3.3.9 Drawing Seals and Signatures. Architect-Engineer designed drawings should each be sealed, signed, and dated by the responsible designer. Electronic duplications of seals are acceptable. However, original, handwritten signatures on plotted record drawings are required.

3.3.10 Amendments to Drawings. Architect-Engineer shall make amendment revisions to the most recent CADD drawings contents and title block. Unless other procedures established by the supervising district are furnished to the A-E, the following procedure shall be followed. Before any solicitation CADD file is amended, a copy of the CADD file or files that make up the drawing shall be saved with a .ORS (original solicitation) extension. In the lower right-hand corner below the title block insert “SUPERSEDED BY (new sheet no.).” Then the original CADD file shall be revised to include the amendment and the file saved as filename.ann where filename is the root name and nn is the amendment number. Amendment numbers should be coordinated with the district project Technical Leader. Circle each of the areas of change for this amendment on the drawing with a dashed line and remove the dashed lines for any previous amendment to that drawing. Place a triangle inside the circled area on the drawing with the assigned lower case change letter (a,b,c) inside the triangle. Place a number outside the triangle in ascending order for each area that has been encircled. The revision block shall contain the date of revision, amendment number (AM000?) and a brief description of the changes on the drawing along with a triangle containing the change letter and number outside to indicate

the number of circled areas. Successive revisions shall be shown progressing upward in the revision block and use ascending change letters (a, then b, then c, etc). The sheet number and sequence number shall be changed by adding a point number. The point number shall be in ascending order depending on the number of amendments to that drawing (sheet number.1 and sequence number.1, then sheet number.2 and sequence number.2, etc). An added drawing shall be indicated as "New Drawing" and deleted drawings shall be indicated as "DELETED FROM CONTRACT" in the revision block. The Drawing Index will reflect the new drawings added and deleted drawings. The amended CADD files shall be submitted to the district in the media required by the A-E Contract.

3.3.11 Construction Modifications. The Architect-Engineer will be requested to make construction modifications by the district project Technical Leader. Modifications will be posted using procedures, similar to the amendment posting procedures described above, established by the supervising district on the latest version of the CADD design files. Unless other procedures established by the supervising district are furnished to the A-E, the following procedure shall be followed. Before any contract drawing CADD file is modified, a copy of the CADD file or files that make up the drawing shall be saved with a .ORG (original contract) extension. In the lower right-hand corner below the title block insert "SUPERSEDED BY (new sheet no.)." Then the original CADD file shall be revised to include the modification and the file saved as filename.mnn where filename is the root name and nn is the modification number. Modification, DO, and file extension numbers will be furnished by the district project Technical Leader. The revision block shall contain the date of revision, modification number (DO000?) and a brief description of the changes on the drawing along with a triangle containing the change number (1,2,3, etc). The sheet number and sequence number shall be changed by adding a point number. The point number shall be in ascending order depending on the number of amendments and modifications to that drawing (sheetnumber.1 and sequence number.1, then sheetnumber.2 and sequence number.2). Modified CADD files shall be submitted to the district Technical Leader in the media required by the AE Contract.

3.3.12 Drawing Submittal Media. The supervising district shall establish the appropriate media and number of copies

for submission of final drawings, and for other required submittals and include these requirements in the A-E Contract. These may be CADD files in .dgn or .dwg format, CAL files, CD-ROM with drawing files (and specifications), and full size or half-size hard copy drawings. If required by contract hard copy Vellum drawings, plotted from CAL files. Each submittal of CADD files shall contain an EXCEL spreadsheet containing the drawing number, sequence number, level/layer assignments, line colors, line weights, line types and any other workspace settings used for every drawing.

4. TYPES OF DRAWINGS

4.1 **Budget Type Sketches/Drawings** are single-line diagrams for estimating costs and programming projects. These drawings are normally reduced for presentation in 216 mm x 279 mm (8 1/2" x 11") Project Engineering (PE), Project Development Brochures (PDB), Army or Requirements and Management Plan (RAMP), Air Force. Minimum size lettering will therefore be equal to 12 point type size after reproduction. Functional data, controlling dimensions and gross area will be shown.

4.2 **DA Standard Designs/Drawings** essentially consist of standard floor plans, typical building sections and special site requirements, without any detailed design developed. Designs are at about the 10% stage. These designs where developed in accordance with ER 15-1-25. Standard design packages are available for about 13 different Army facilities with about 15 others under development. Use of these standards for Army projects is mandatory and will be required by the DD 1391 form. Standards are available through the Internet at http://cadib.wes.army.mil/html/cos/cfusion/MainPage.htm Drawings in these packages are CADD MicroStation files. Deviations from these standards are not permitted without waiver approval.

4.3 **Site-Adapted Drawings** are plans from a prior project. The level of implementation will be technically coordinated by district staffs. Typically site-adapted plans will be reviewed by each design discipline for updating to current criteria for the specific construction site. Site-adapted drawing title blocks shall be changed by deleting the original AE name and seal, replacing the project name with

the current project name, deleting all amendment and modification notations and symbols throughout the drawing, and adding a note above the title block indicating the project from which the drawing has been site adapted.

4.4 **Standard Drawings** Standard drawings are fully developed plans and complete details for use in repeated locations or for site adaptation as follows:

4.4.1 Field Standards are District or local standards derived from prior projects.

4.4.2 Regional Standards are Division or uniform criteria standards established for regional, climatic and other environmental design conditions. Plates at the end of chapters in this AEIM are regional standards. Supervising districts may have additional standards. The AE should request a list of Standard Detail files available in MicroStation® or AutoCad® format, from the district project Technical Leader.

4.4.3 HQUSACE Standards are national standards. These documents which are to be utilized as completely as practicable for project design conditions. Analyses of foundations, structural and mechanical systems are normally authorized to site adapt the drawings. Revisions and deviations beyond these shall be reported and submitted for approval through the Technical Leader in the supervising district, to CESWD-ETEC-T to HQUSACE.

4.5 **Project Drawings** are developed for actual construction at an individual site. They may be site-adaptations of standard plans or new and original design document submittals as follows;

4.5.1 Schematics/Sketches are single-line drawings to scale representing 5-10% project design development. They include but are not limited to basic site plan (including orientation and contours), floor plan (with overall dimensions), gross area, two elevations and a section.

4.5.2 Army Project Engineering and Air Force Project Definition are double-line drawings to scale, with dimensions, representing 10-30% (actual % as specified by contract Scope of Work) project design development. They include but are not limited to a site plan showing proposed

buildings, roads, parking, etc., utilities layout for electrical, gas, water, steam, etc., floor plan(s) showing functional space arrangements, building elevations, and sections to identify exterior wall system and architectural style, sections to show type of floor and roof structure, single line ductwork layout, mechanical room layout.

4.5.3 Army Concept are double-line drawings to scale with control dimensions representing 25-35% project design development. Comprehensive basic layouts with net areas and equipment are required for each design discipline. A preliminary fire protection plan, elevations, cross-section and typical wall section are required.

4.5.4 Final and Corrected Final Drawings are complete civil, architectural, structural, mechanical and electrical drawings including all building components, controlling dimensions, sections and details for efficient execution of construction. Drawings will be independently checked and thoroughly coordinated with specifications terminology for accurate take-off and competitive bidding by contractors.

4.5.5 Demolition Drawings will show all of the existing construction to be changed or removed. Notes, dimensions and details will be explicit for accurate sizing, take-off of quantities and estimating. Provide a schedule identifying characteristics of mechanical/electrical equipment to be removed or relocated.

4.5.6 As-Built Plans are completed sets of drawings with all attendant changes, modifications and details of construction as built and installed. Sets of As-Built Plans of will be furnished as required to the using agency for future reference, maintenance and construction on the facility. A Master set of CADD files of the project drawing records will be retained at the District for a period of 5 years and then sent to the using agency.

5. **FORMAT OF PLANS** The number of drawings will vary according to the scope and requirements of each project. Experience has shown that following the guidance below results in clear construction contract documents.

5.1 **Arrangement of drawings** will be as shown on plate D1 of Appendix A.

5.2 **Separate Drawings.** Typically to avoid congestion, provide separate drawings as listed below.

5.2.1 Project Site Plan(S) Project site plans are typically provided in civil drawings, in demolition plans, for exterior utilities, etc.

5.2.2 Demolition Plans (buildings, paving, utilities, etc.)

5.2.3 Grading, Paving and Drainage Plans

5.2.4 Exterior Utilities (water, sewer, gas, etc.)

5.2.5 Exterior Electrical Utilities (power distribution)

5.2.6 Plumbing

5.2.7 HVAC

5.2.8 Lighting System

5.2.9 Power System

5.2.10 Communications, Signaling, and other special systems (e.g., telephone, fire alarm, intercom,)

5.2.11 Fire Protection Plan

5.3 **Cover Sheet.** Each set of plans or volume in a set of plans should have a cover sheet. Cover sheets contain the base name, official title of the project, volume number when there are multiple volumes in a set, Corps Of Engineers logo, name of district responsible for the preparation of the contract plans, solicitation number and issue date, and after award of the contract for construction the contract number. The A-E should obtain the format for the sheet from the district project Technical Leader. Solicitation and contract numbers will be assigned by the district.

5.4 **Index of Drawings** may be a separate sheet, sheet for each volume of the plans, or for small projects combined with the project location sheet. Place the index of drawings behind the cover sheet. Arrange so that additional numbers can be added in each technical discipline.

5.5 **Project Vicinity, Location and Haul Route.** A vicinity map and base layout map to be used for project location and the haul route will be furnished by the supervising Corps district. This information should be included on a separate sheet following the index sheet.

5.6 **Legends and symbols** will be complete and concise for the project design. District standard symbols will be used to depict all work items on boring logs, civil drawings, architectural drawings, mechanical drawings, electrical drawings, and landscaping. AIA standards may also be utilized. The ampersand (&) will not be used in sentences and schedules. Additional symbols may be used by the design agent to correlate project drawings by discipline. A consolidated legend/symbol sheet for the entire project may be provided or separate legend/symbol on discipline drawings may be provided.

6. DRAWING STANDARDS

6.1 **Scale** for all drawings and delineation will permit complete legibility. A graphic bar or checkerboard scale will be provided on each sheet near the lower left hand corner of the sheet. Conventional scale standards are as follows:

Site Plans (Buildings)	No smaller than 1:200
Floor Plans*	1:50 to 1:100
Roof Plan	1:100
Exterior Elevations	1:100
Interior Elevations	1:50
Cross Sections	1:50 to 1:100
Wall Sections	1:20
Stair Details	1:20
Details	1:5 or 1:10

* A minimum scale of 1:50 is required for family housing, medical centers and all areas of congestion such as mechanical rooms, restrooms, kitchens etc.

6.2 **Lettering**. Computer lettering will be in the font and line weight standard used by the district. Lettering will not

be less than "this type-size", after reduction, for any reduced presentation.

6.3 **Sheet Numbers** will be indexed and assembled by disciplinary group in the set of drawings. Unless otherwise approved by the design district, the sheet number should consist of a capital alphabetical letter representing the discipline followed by a number indicating its sequence in the discipline group. The designations for the disciplines are C for civil/site, A for architectural, S for structural, M for mechanical, E for electrical, BL for boring location and log of borings, L for turfing and landscaping.

6.4 **North Arrows** will be placed on the plan sheets for each discipline. The north arrow will be on the key plan if used and oriented to the top of the sheet where practicable. The true meridian and magnetic declination will be shown on all maps. When a coordinate system is used for civil drawings, grid north will be shown.

6.5 **Titles** must be used to identify the view and also what the view is representing; SITE PLAN, PIPING PLAN, FLOOR PLAN, NORTH ELEVATION, WINDOW JAMB DETAIL, CROSS SECTION A-A, etc.

6.6 **Section and Detail Cross References** should follow the sheet number where cut/sheet number where shown convention shown on plate D2 in Appendix A unless otherwise approved by the district. Section and cross reference standard symbols, should typically have a title to provide sufficient identification to clarify location of the sections/details, such as JOINT DETAIL, ELECTRICAL PANEL ELEVATION, etc. The title may have more than one line and may have subtitles and explanatory notes.

6.7 **Photographs** may be used to better illustrate existing conditions. Photos used for modification work or maintenance work should use pencil changes and dimensions drawn on the photos with clarifying notes. Photos should be not less than 100 mm x 125 mm (4" x 5") and not larger than 200 mm x 250 mm (8" x 10"). When appropriate graphic scales should be included so the dimensions can be scaled.

6.8 **Dimensions/Grid** will be carefully checked and coordinated between disciplines for accuracy. Plan dimensions for wall frame construction will be to face of stud and to centerline of openings. Masonry construction

dimensions will be to nominal face of masonry and to jambs of openings. Modular design will be used for all masonry and dimensions will be in increments of 10 mm to reduce on-site cutting for hard metric masonry units. Control dimensions will be to the same points on architectural and structural drawings. Where columns occur, a dimensional grid system will be set to column centerlines.

6.9 **Finished Drawings/Checking**. All drawings submitted will be marked to their submittal level (i.e. Advance Final, Final, etc.). The medium for submission shall be in the contract documents or established by the district project Technical Leader. Notes and terminology will be consistent with guide specifications. General notes will be grouped and special notes will provide specific reference, i.e. See Structural Dwg.S-1. "By Others" should not be used. Work shown, but not existing and not in the construction contract, will be designated as NIC (not in contract). Sectioning, cross-referencing and general titling guidance are as shown on plate D2 of Appendix A in this chapter. Detailing should be consistent with stock materials and standard construction practices. Details should provide thorough and unambiguous guidance for basic materials of construction. Details for options should be consistent with reasonable selections from the guide specifications for project design conditions.

6.10 **Reproduction Process**. Specific requirements for the reproduction process to be used for each project will be furnished by the supervising district. See paragraph 3.3.12 above.

6.11 **Electronic Bid Set.** When required by the contract Scope of Work, the AE shall provide the final drawings (and specifications) on CD-ROM. Drawings will be converted to CAL file format before placing them on the CD-ROM. Digital files for use on the Electronic Bid Set CD's shall be furnished as directed by the supervising district.

7. **PROJECT DRAWING DATA** See Civil Chapter II, Architectural Chapter III, Structural Chapter IV, Mechanical Chapter V, Electrical Chapter VI, and Part 2, Chapters 1 through 8 in Design Analysis Chapter IX for requirements in addition to the following:

7.1 **Project Site Plans** will show north arrow, existing contours, existing and adjacent facilities, topographic

features and utilities interface for complete interdisciplinary coordination of the proposed site design.

7.2 **Floor Plans** will show complete horizontal controlling dimensions and civil/site interface. Reference all section cut lines on plan to the appropriate sheet where the section is shown. Built-in, installed and portable equipment will be indicated to scale. For major items of mechanical/electrical equipment, use the larger of three manufacturers equipment sizes for space requirements.

7.3 **Fire Protection Plans** will be provided for Army project engineering, Air Force Project Definition, Concept, Final and Corrected Final submittals. Plans will indicate hazards, clearances, rated wall systems, fire exits and distances. Gross floor areas will be listed for each floor and for the building.

7.4 **Room Finish/Color Schedules** will be provided on (or follow) the floor plan sheet, be complete for each wall orientation and consistent with fire protection plan ratings, interior design finishes and project specifications terminology. All spaces in the schedules will be filled in. Where surfaces have no finish, the word "none" will be used. Ditto marks will not be used.

7.4.1 Interior Finish Schedules will cover all built-in items requiring finish including cabinets, counter tops, acoustical materials and mechanical/electrical equipment exposed to view. Schedules will stipulate surfaces to receive paint by type and texture and the specifications will be coordinated therefore.

7.4.2 Exterior Finish Schedule will include the finish and texture for all exterior materials exposed to view. Exterior metal work such as doors, windows and metal fascia will be compatible.

7.5 **Elevations** will show all visible elements including adaptation to finish grade, story heights, fenestration and mechanical/electrical equipment and screening of appearance distractions. Indicate rustication, control, construction and expansion joints and coordinate with structural drawings.

7.6 **Longitudinal and Cross-Sections** will be taken to show all building framing sub-assemblies and suspension systems.

7.7 **Wall Sections** will show comprehensive variances in construction with complete vertical dimensions. Sections will be structurally coordinated for:

7.7.1 Foundation and finish grade conditions.

7.7.2 Size and spacing of horizontal and vertical reinforcement and masonry ties

7.7.3 Control joint placement and details

7.7.4 Suspension and furring assemblies including wind up-lift and seismic bracing details.

7.8 **Doors** will be drawn to scale, each with a separate number and door swing shown in plan. Door elevations and details will show transoms, sidelights, glazing and louvers. Doors will be numbered consecutively and counter-clockwise in plan as follows:

Basement ------- 01 through 99
1st Floor ----- 101 through 199
2nd Floor ----- 201 through 299
etc.

7.8.1 Door Schedules will list each door by separate number and segregate by type, material, fire rating, hardware, threshold and detail references. Schedules will be coordinated with fire protection plans, security criteria, and specifications. Each frame type will be identified by double letters (AA, BB, CC etc.)

7.9 **Windows and Schedules** will include all the various types and options used with references to head, jamb and sill details. Each window type will be designated by "W" and number (W-1, W-2, etc.). Window details should be coordinated with energy conservation fenestration and solar shading.

7.10 **Roof Plans** will show all access, slopes, drainage flow, scuppers, roof mounted equipment, walkways, and skylighting. Provide references for all flashing details, horizontal joints, intersections, and penetrations. When built-up roof systems are used, detail uniform shaped penetrations with

clamped bell-flashing and non-uniform shaped penetrations with pitch pockets.

7.11 **Ceiling Plans** will show all special architectural features and mechanical/electrical fixtures and will be coordinated with fire rated assemblies and sprinkler system.

7.12 **Sections and Details**. Cuts will be comprehensive for construction and identified with correct number and sheet to accurately show dimensions, type and extent of materials.

7.13 **Equipment Schedules** will list identification nomenclature for each piece of equipment, stating size, mounting provisions, utility service and capacity requirements. Additionally denote Government Furnished/Contractor-Installed equipment and all Government-Furnished and Installed equipment. Medical and laboratory equipment schedules will be as specifically directed for the project.

8. **AMENDMENTS AND MODIFICATIONS**. Revisions to drawings will meet the drafting standards used in the development of Final Plans for uniformity. The district project Technical Leader will coordinate between the Corps of Engineers Construction representative and A-E and furnish direction therefore. See paragraphs 3.3.10 and 3.3.11 of this chapter for additional guidance.

APPENDIX A

CHAPTER VIII

INDEX OF PLATES

STANDARD ARRANGEMENT OF DRAWINGS

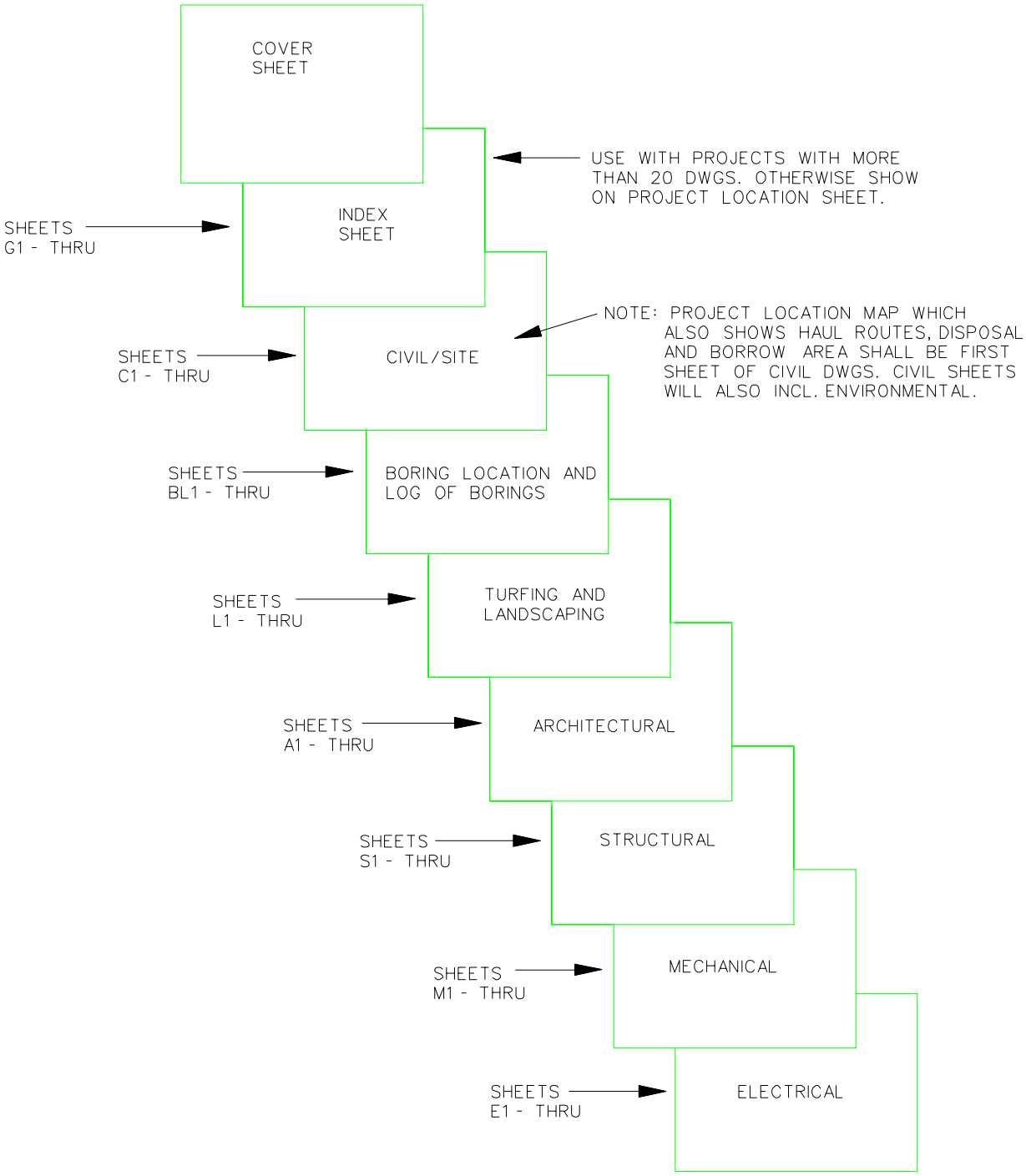
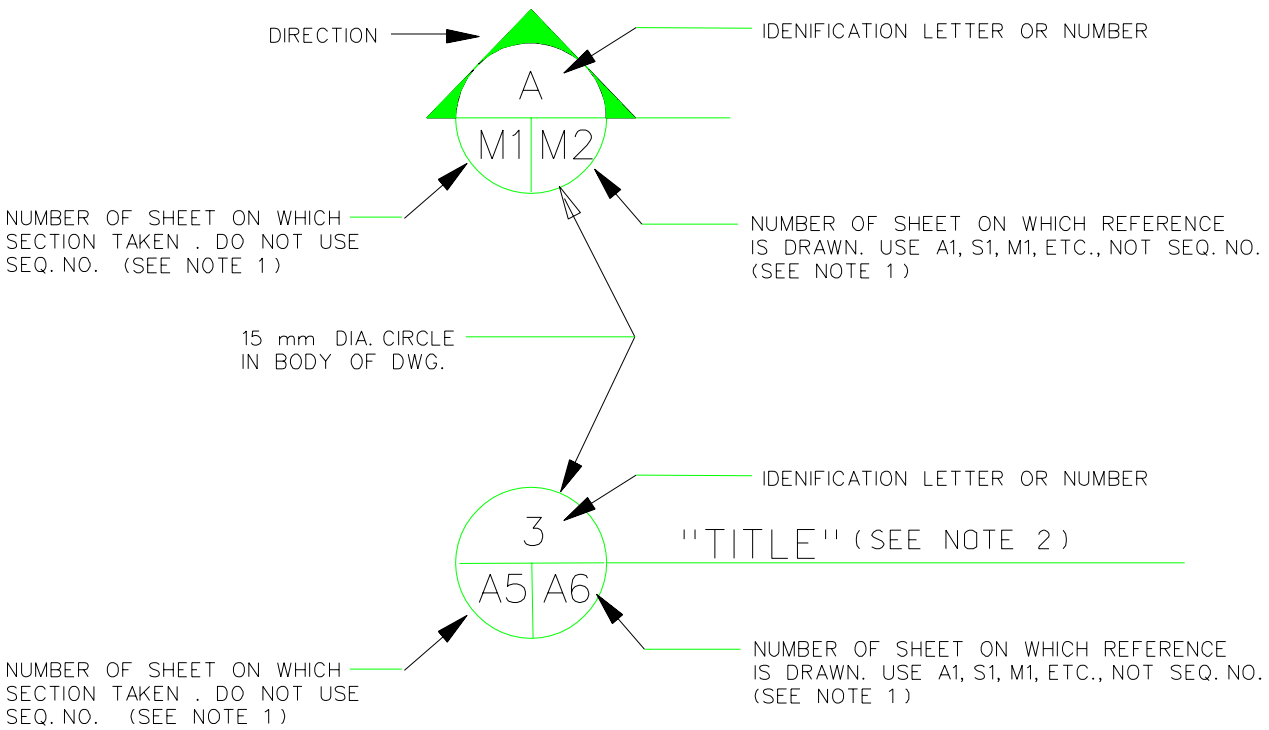


PLATE D1

ELEVATION, SECTION & DETAIL CROSS REFERENCES

NOTE TO DESIGNER:
THE FOLLOWING SECTIONING/DETAILING CONVENTIONS WILL BE USED ON ALL WORKING AND FINAL DRAWINGS.



NOTE 1: ELEVATION, SECTION & DETAIL REFERENCES. SHOWN ARE EXAMPLES ONLY. USE THE PROPER DESIGNATION FOR EACH DISCIPLINE.

C = CIVIL
A = ARCHITECTURAL
S = STRUCTURAL
M = MECHANICAL
E = ELECTRICAL

BL = BORING LOC. & LOG OF BORINGS
L = TURFING & LANDSCAPING

NOTE: TRI-SERVICES CADD/GIS STANDARDS CONTAIN ADDITIONAL DISCIPLINE DESIGNATIONS.

NOTE 2 : A TITLE MUST IDENTIFY THE VIEW AS A PLAN, ELEVATION, SECTION, SECTIONAL ELEVATION, ETC. THE TITLE MUST ALSO IDENTIFY WHAT THE VIEW IS REPRESENTING: ELECTRICAL SITE PLAN, PIPING PLAN, ETC. THE WORD "DETAIL" OR "VIEW" OR "ELEVATION" EVEN IF USED WITH A CROSS-REFERENCE BUBBLE. IS NOT A SUFFICIENT IDENTIFICATION OF THE VIEW. A TITLE MAY HAVE SUBTITLES AND EXPLANATORY NOTES.